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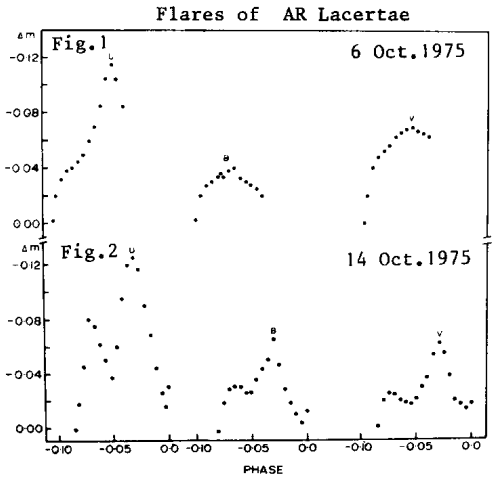
# FLARE LIKE ACTIVITY IN AR LACERTAE

The system AR Lac (=BD +45°3813 = HD 210334 = HV 2980 = HR 8448) is an interesting RS CVn binary. The system is known to be a radio source (vide Hjellming and Blankenship, 1973; Gibson and Hjellming, 1974; Spangler et al., 1977; Feldman, 1978; Owen and Gibson, 1978; Walter et al., 1978) showing variable radio emission and also occasionally flaring activity. Ultraviolet observations by Kiziloğlu et al. (1983) through IUE show that it is an active star. H and K emission of CaII and H-alpha emission are found to be present in the system, which indicate that this system has an active chromosphere.

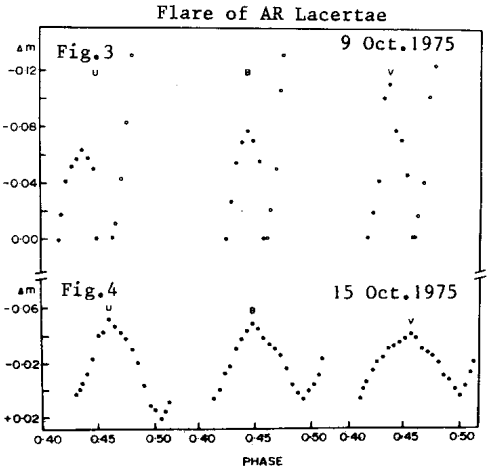
So far UBV flares have been observed in two RS CVn stars, SV Cam (Patkós, 1981) and XY UMa (Zeilik et al., 1982, 1983).

UBV observations of AR Lac were secured during the period October 1975 to January 1976 and some interesting features in the light curves of the system, particularly, an additional light of the order of $0^m.10$, just preceding primary minimum, and of the order of $0^m.05$, just preceding secondary minimum, in all the colours were reported (Srivastava, 1981). These appeared as humps on the shoulders of both the eclipses. The nature of these additional lights has been investigated in this communication.

The additional lights have been observed on four nights (6 October 1975, 9 October 1975, 14 October 1975 and 15 October 1975) in all the three filters. Two nights (6 October 1975 and 14 October 1975) are related to the ingress part of the primary eclipse, while the remaining two nights (9 October 1975 and 15 October 1975) are concerned with the ingress part of the secondary eclipse. The additional lights observed on all the four nights have been obtained by taking the difference of observed and computed lights of the system from the smoothened light curves. These differences are plotted in Figures 1, 2 and Figures 3, 4 for primary and secondary eclipses, respectively. The figures show that flare-like activity is present in the system. The characteristics of flares are given in Table I.




Figures 1-2
Flares of AR Lacertae during primary minimum




Figures 3-4
Flares of AR Lacertae during secondary minimum. Filled and open circles represent the first and the second flares, respectively.

Table I

Characteristics of the flares of AR Lacertae

| Min. | Date 1975 | Filter | Start time of flare (UT) | End time of flare (UT) | Duration of flare | Time of maxima of flare (UT) | Maximum amplitude of flare (mag.) |
|---|---|---|---|---|---|---|---|
| Pr. | 6 Oct. | U | $16^h\ 33^m.1$ | $19^h\ 28^m.9$ | $02^h\ 55^m.8$ | $18^h\ 57^m.6$ | $0^m.12$ |
| | | B | 16 36.4 | 19 28.9 | 02 52.5 | 18 12.7 | 0.04 |
| | | V | 16 40.3 | 19 28.9 | 02 48.2 | 18 42.1 | 0.07 |
| | | | First flare | | | | |
| Sec. | 9 Oct. | U | 16 45.6 | 18 06.6 | 01 21.0 | 17 30.4 | 0.06 |
| | | B | 17 13.2 | 18 44.9 | 01 31.7 | 18 09.1 | 0.08 |
| | | V | 16 56.4 | 18 41.2 | 01 44.8 | 17 37.6 | 0.11 |
| | | | Second flare | | | | |
| | | U | 18 44.9 | 19 36.5 | 00 51.6 | 19 36.5* | 0.13* |
| | | B | 18 59.1 | 19 40.4 | 00 41.3 | 19 40.4* | 0.13* |
| | | V | 18 44.9 | 19 36.5 | 00 51.6 | 19 36.5* | 0.12* |
| Pr. | 14 Oct. | U | 15 50.4 | 19 32.9 | 03 42.5 | 16 32.0 | 0.15 |
| | | B | 16 14.2 | 19 32.9 | 03 18.7 | 16 32.0 | 0.07 |
| | | V | 15 50.4 | 19 32.9 | 03 42.5 | 16 32.0 | 0.06 |
| | | | First flare | | | | |
| Sec. | 15 Oct. | U | 16 25.3 | 19 22.5 | 02 57.2 | 17 44.8 | 0.05 |
| | | B | 15 51.6 | 18 52.1 | 03 00.5 | 17 15.9 | 0.05 |
| | | V | 15 23.8 | 19 03.1 | 03 39.3 | 17 30.2 | 0.04 |
| | | | Second flare | | | | |
| | | U | - | - | - | - | - |
| | | B | 19 46.1 | 20 07.8 | 00 21.7 | 00 21.7* | 0.02* |
| | | V | 19 47.9 | 20 07.8 | 00 19.9 | 00 49.9* | 0.02* |

*These values do not relate to the actual times of maxima, amplitudes of the flares, but are only apparent values as the secondary flares have not been observed fully.

The average standard deviation of individual observations of comparison star is $0^m.02$.

In both the flares of secondary minima (Figures 3 and 4), the flares start from the normal light (quiescent) level, rise to the maximum light (flare) level and then subside and return to the quiescent level. However, the flare curves of 9 October 1975 show a sharp rise and a sharp decline while the flare curves of 15 October 1975 show a slow rise and a slow decline.

The second flare starts on these nights after the main burst. The rise during the second flare is not conspicuous on 15 October 1975 in the U filter due to considerable scatter present in the observations. The secondary flares seem to be more intense showing steeper rise.

The flares of primary minima on 6 October 1975 and 14 October 1975 show declining tendency after the start and then rise to the maximum intensity before the last decline. The flares of 14 October 1975 do not decline to the quiescent levels, but show a tendency to rise before the last decline. The

duration of flare on 14 October 1975 is the longest. The pattern of flare of 14 October 1975 indicates that sympathetic flare may have been associated with the preceding flare as is shown in the case of EV Lac (Godoli, 1968). The flares of 6 October 1975 have not been observed fully.

This is the first reporting of the flares in the UBV region for AR Lac.

The author has interpreted these additional light's phenomena on the plausible basis of flare-like activity. However, the alternative interpretations of these additional lights, if any, would need further investigation.

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